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(56) Documents cited
GB 0393341 A GB 0228559 A WO 86/07418 A
US 4577677 A

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(54) **Plate-type heat exchanger**

(57) A plate-type heat exchanger comprises a plurality of plates (20) between which are defined channels (22, 28) for two fluids, and a valve (32) movable along a header (27) and arranged to restrict flow of fluid to successive pairs of adjacent channels (28A) connected to that header. The fluid flowing in the intervening channel (22A) does not undergo heat exchange and therefore dissolves solid materials deposited in that channel. Waxy deposits from a crude oil stream can for example be removed from a heat exchanger used to cool crude oil. The valve may be adapted to inject hot water or steam into the channels. Alternatively, each channel may be associated with a respective valve, pairs of adjacent valves being activated in sequence. Alternatively, or additionally, means within the headers may inject steam or solvent into the crude oil channels.

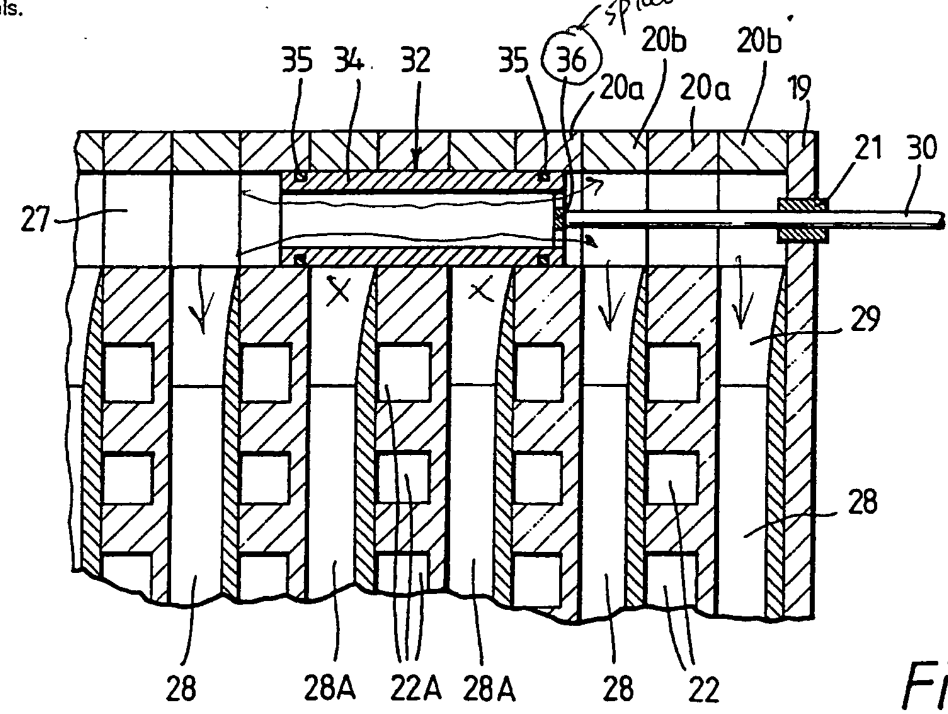

Fig. 4.

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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4/13/06, EAST Version: 2.0.3.0

Fig. 1.

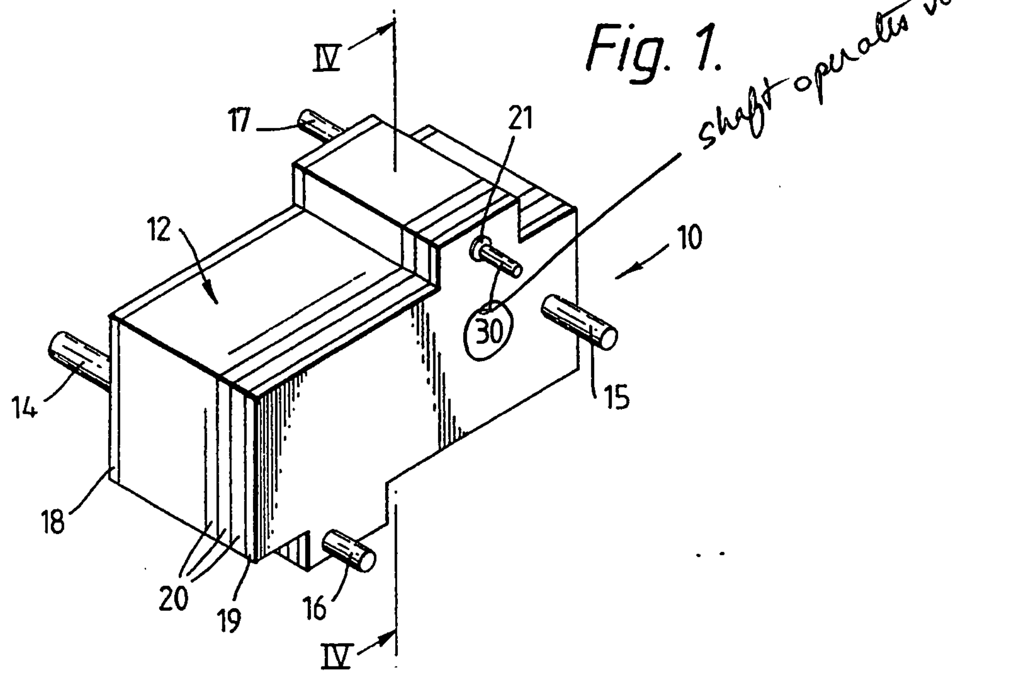

Fig. 2.

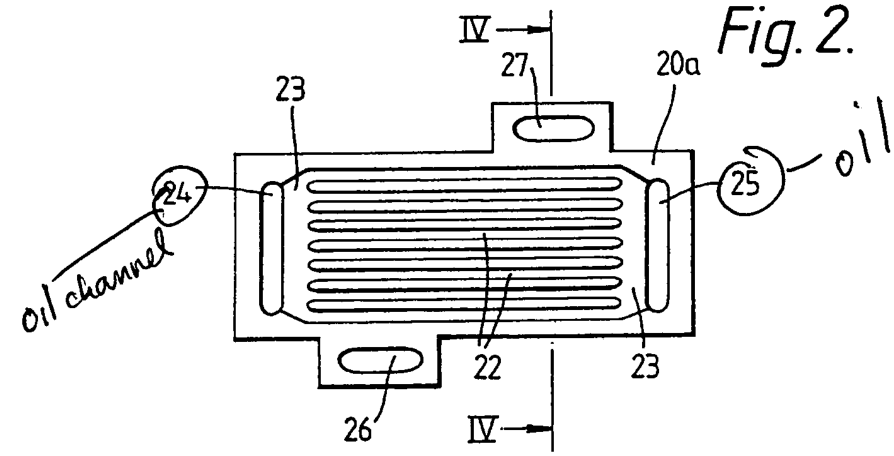

Fig. 3.

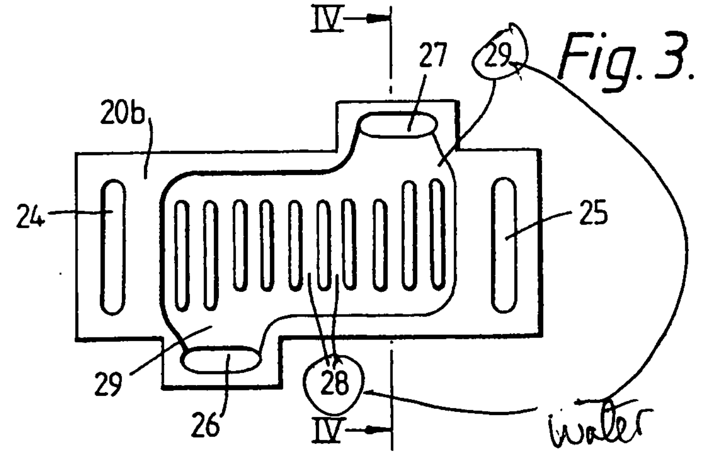

Fig. 4.

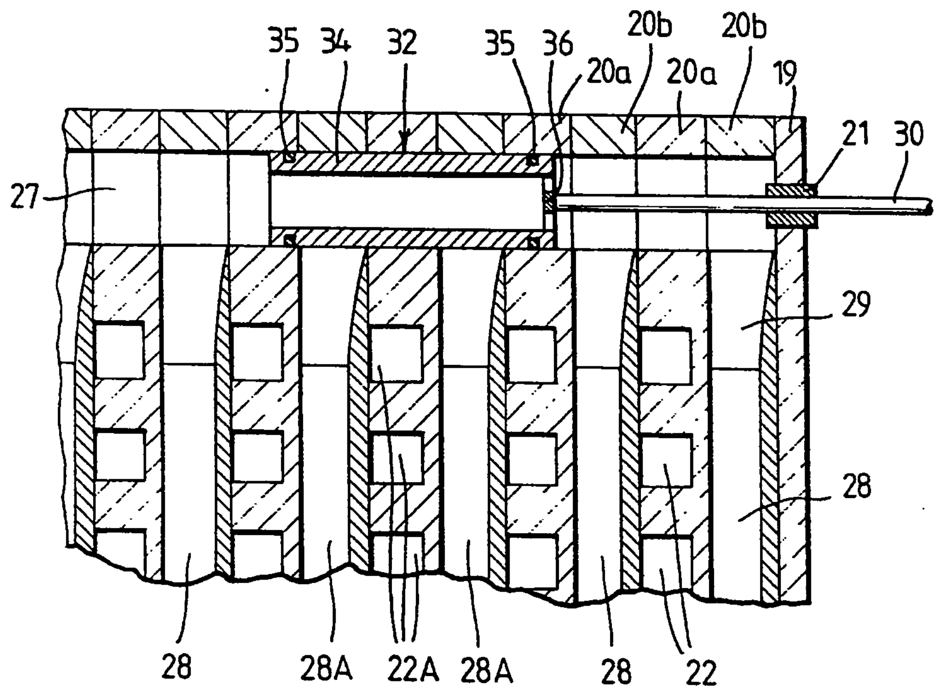

Plate-Type Heat Exchanger

This invention relates to a plate-type heat exchanger, particularly but not exclusively to such a heat exchanger for use in cooling a crude oil containing waxy components, and to a method for removing deposits from such a heat exchanger.

Where a crude oil containing waxy components is cooled by passage through a heat exchanger there is a tendency for solid wax to be deposited on the surfaces of the channels through which the crude oil flows, restricting the oil flow and eventually leading to blockage. This problem can be circumvented by having two heat exchangers connected in parallel, and using them alternately while the one not in use is cleaned, but this is expensive.

According to the present invention there is provided a plate-type heat exchanger comprising a plurality of parallel plates and defining between the plates channels for two fluids, and with a header in fluid communication with alternate channels, also comprising means to alter the flow of fluid into the channels which communicate with the said header, the altering means being arranged to alter the flow into at least one of said channels at a time, and means to ensure that the flow is altered into each of the said channels over a period of operation.

The altering means may comprise means to inject a third fluid, for example a solvent, or steam, into one or more of said channels. This enables wax deposits to be removed from channels carrying crude oil through a heat exchanger, although it does add solvent or water to the outflowing crude oil stream. This can be avoided by also providing means operated in synchronism with the injector means to withdrawn fluid from the said channels.

More preferably the altering means comprises means to restrict the flow into at least a pair of adjacent said channels at a time. Preferably the restrictor means comprises valve means movable along the said header, the valve means being such as to restrict the flow into at least a pair of adjacent said channels, and the ensuring means comprises means to move the valve means along the said header. Desirably the valve means is such as to prevent fluid flow into the said pair of adjacent channels. The valve means may also incorporate means for injecting a third fluid into the said pair of channels.

Where crude oil containing waxy components is to be cooled by heat exchange with cold water, using the heat exchanger incorporating a restrictor means of the invention, the header containing the valve means is a header for the water. The valve means therefore restricts or cuts off the flow of cooling water to a pair of water channels; between these channels is a channel for crude oil which is consequently not cooled by passage along the channel and which therefore re-dissolves any waxy material deposits from the walls of the channel.

The invention also provides a method for removing deposits of material from channels of a plate-type heat exchanger, the heat exchanger comprising a plurality of parallel plates and defining between the plates channels for two fluids, and with a header in fluid communication with alternate channels, the method comprising altering during operation the flow of fluid into the channels which communicate with the said header, in such a manner as to alter the flow into at least one of said channels at a time, and in such a manner as to alter the flow into each of the said channels over a period of operation.

The flow may be altered by injecting a third fluid into the said channels, being the channels from which the deposits are to be removed. Alternatively the flow may be altered by restricting the flow into at least a pair of adjacent channels at a time, not being the channels from which the deposits are to be removed.

The invention will now be further described by way of example only and with reference to the accompanying drawings in which:

Figure 1 shows a perspective view of a heat exchanger;

Figure 2 shows a plan view of one plate of the heat exchanger of Figure 1;

Figure 3 shows a plan view of another plate of the heat exchanger of Figure 1; and

Figure 4 shows a sectional view along the plane IV-IV of Figure 1 (corresponding to lines IV-IV in Figures 2 and 3), partly broken away.

Referring to Figure 1, a heat exchanger 10 for heat exchange between cooling water and a crude oil comprises a laminated heat exchange unit 12 to which are connected four tubes - an inlet tube 14 for the crude oil, an outlet tube 15 for the oil, an inlet tube 16 for the water, and an outlet tube 17 for the water. The heat exchanger 12 is formed of a large number of plates 18, 19, 20, each of the same generally rectangular shape with two staggered rectangular projections on two opposite sides. The outermost plates 18, 19 each define two circular apertures to which the tubes 14 and 17, or 15 and 16 respectively, are welded, and the plate 19 also defines an aperture in which is a gland 21 for a valve operating shaft 30 to be

described later. The remaining plates 20 are of two types arranged alternately, plates 20a as shown in Figure 2, and plates 20b as shown in Figure 3.

Referring to Figures 2 and 3, all the plates 20 define apertures 24 and 25 at opposite ends of the rectangular portions, and apertures 26 and 27 in the rectangular projections. The plates 20a are provided on one surface with a large number of parallel grooves or channels 22 between fins extending parallel to the longer sides of the rectangle, the channels 22 being of uniform depth (only eight are shown). The grooves 22 communicate at their ends with the apertures 24 and 25 via curved header grooves 23 of increasing depth and of greater width than the grooves 22. Referring to Figure 3, the plates 20b are provided on one surface with a large number of parallel grooves or channels 28 between fins extending parallel to the shorter sides of the rectangle (only eleven are shown). These grooves 28 communicate at their ends with the apertures 26 and 27 via wider, curved, header grooves 29 increasing in depth towards the apertures 26 and 27. The plates 18, 19, 20 may be bonded to each other metallurgically, or be held together by bolts (not shown).

In use of the heat exchanger 10 the grooves 22 and 23 provide channels for the crude oil flow between the tube 14 and the tube 15, the aligned apertures 24 and 25 acting as headers for the oil. Equally the grooves 28 and 29 provide channels for the water flow between the tubes 16 and 17, the aligned apertures 26 and 27 acting as headers for the water, and the water flow is therefore cross-flow relative to the flow of oil. Since the plates 20a and 20b are arranged alternately, each flow channel for oil is sandwiched between two flow channels for water. During operation there is a tendency for waxy materials dissolved in the crude oil to deposit on the surfaces of the channel (e.g. in the grooves 22) as the crude oil is cooled.

Referring to Figure 4, within the header for coolant water defined by the aligned apertures 27 is a valve 32. The valve 32 consists of a tubular valve member 34 of the same cross-sectional shape as the apertures 27 and of length just greater than four times the thickness of a plate 20, with rubber O-rings 35 locating in external peripheral grooves near each end, connected to the shaft 30 by a spider 36 so as to be slidable along the header. The valve 32 may be slid along the header manually or by a mechanism (not shown) connected to the shaft 30, the shaft 30 sliding through the gland 21 which prevents water from leaking from the header.

With the valve 32 in the position shown, the coolant water is prevented from flowing in two adjacent channels (the grooves indicated 28A); the crude oil flowing in the channel (grooves 22A) in between those two water channels is not cooled, and therefore dissolves any wax deposits in that channel. Hence by sliding the valve 32 gradually from one end of the header 27 to the other, either continuously or intermittently, the wax deposits are removed before they block the crude oil channels. The heat exchanger 10 can therefore be operated continuously, and does not have to be shut down to remove wax deposits.

It will be appreciated that the heat exchanger 10 can be modified in many ways while remaining within the scope of the invention. For example the valve 32 might be of different shape to that described and of different size, as long as it restricts water flow to at least a pair of adjacent water channels. In the present case the valve member 34 is tubular so as not to impede water flow from the end of the header remote from the tube 17, but if there were tubes 17 connected to each end of the header then the valve member 34 might not be tubular. Furthermore the valve 32 might be installed in the inlet header (apertures

26) instead of the outlet header (apertures 27). In this case it might also incorporate means to inject a hot fluid (such as hot water or steam) into those channels in which coolant water flow is prevented; in addition a valve 32 might be installed in the outlet header, moved in synchronism with the valve 32 in the inlet header, and incorporating means to withdraw the hot fluid from those channels so that it does not mix with the outflowing coolant water. Furthermore in each case the valve 32 might be arranged to merely restrict coolant flow rather than preventing it.

It should also be appreciated that instead of a valve 32 movable along the header there might be a plurality of valves each arranged when activated to restrict or prevent coolant flow in one channel, pairs of adjacent valves being activated in a sequence so that over a period of time all the pairs of adjacent valves are activated and so wax deposits are removed from all the oil channels.

Instead of, or in addition to, the flow restricting techniques described above which are applied to the water flow, means might be provided within the headers for crude oil to inject steam into one or more crude oil channels at a time and so to dissolve any wax deposits. This may be done using a valve similar to that described above except that it is only necessary to inject steam into one channel at a time; similar means may also be provided in the outflow crude oil header to withdraw the steam so it does not mix with the cooled oil. Instead of steam, an appropriate solvent for the wax might be used.

It will also be understood that the design of the heat exchanger itself is not critical; for example the headers can be of any cross-sectional shape, and might be separate components attached to the outside of a laminated

plate-type heat exchanger, rather than being integral and defined by the laminations themselves. Rather than the plates being integral with the fins, plates might be spaced apart by sets of fins and surrounding gasket members, forming the type of heat exchanger which may be referred to as a plate-fin heat exchanger.

Claims:

1. A plate-type heat exchanger comprising a plurality of parallel plates and defining between the plates channels for two fluids, and with a header in fluid communication with alternate channels, also comprising means to alter the flow of fluid into the channels which communicate with the said header, the altering means being arranged to alter the flow into at least one of said channels at a time, and means to ensure that the flow is altered into each of the said channels over a period of operation.

2. A plate-type heat exchanger as claimed in Claim 1 wherein the altering means comprises means to restrict the flow into at least a pair of adjacent channels at a time.

3. A plate-type heat exchanger as claimed in Claim 2 wherein the restrictor means comprises valve means movable along the said header, the valve means being such as to restrict the flow into at least a pair of adjacent said channels, and the ensuring means comprises means to move the valve means along the said header.

4. A method for removing deposits of material from channels of a plate-type heat exchanger, the heat exchanger comprising a plurality of parallel plates and defining between the plates channels for two fluids, and with a header in fluid communication with alternate channels, the method comprising altering during operation the flow of fluid into the channels which communicate with the said in such a manner as to alter the flow into at least one of said channels at a time, and in such a manner as to alter the flow into each of the said channels over a period of operation.

5. A method as claimed in Claim 4 wherein the flow is altered by injecting a third fluid into the said channels, being the channels from which the deposits are to be removed.

6. A method as claimed in Claim 4 wherein the flow is altered by restricting the flow into at least a pair of adjacent channels at a time, not being the channels from which the deposits are to be removed.

7. A plate-type heat exchanger substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

8. A method for removing deposits of material of channels from a plate-type heat exchanger substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

ıtents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

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Relevant Technical fields

(i) UK Cl (Edition K) F45

(ii) Int Cl (Edition 5) F28G; F28F

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASES:WPI

Search Examiner

A N BENNETT

Date of Search

27 JANUARY 1992

Documents considered relevant following a search in respect of claims 1;4

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 0393341 A (LUNGSTROMS A/B) see especially page 5, lines 17-30	1,4 at least
X	GB 0228559 A (FORSSBLAD) see especially page 2, from line 106	1,4 at least
X	WO 86/07418 A1 (BOLMSTEDT) see Figure 1	1 at least
A	US 4577677 A (PHILLIPS) whole document	1,4

SF2(p)

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Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).

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EUR-CL (EPC): **F28F027/02**

US-CL-CURRENT: 165/166

ABSTRACT:

CHG DATE=19990617 STATUS=O> A **plate**-type heat exchanger comprises a plurality of **plates** (20) between which are defined channels (22. 28) for two fluids, and a valve (32) movable along a header (27) and arranged to restrict flow of fluid to successive pairs of adjacent channels (28A) connected to that header. The fluid flowing in the intervening channel (22A) does not undergo heat exchange and therefore dissolves solid materials deposited in that channel. Waxy deposits from a crude oil stream can for example be removed from a heat exchanger used to cool crude oil. The valve may be adapted to inject hot water or steam into the channels. Alternatively, each channel may be associated with a respective valve, pairs of adjacent valves being activated in sequence. Alternatively, or additionally, means within the headers may inject steam or solvent into the crude oil channels. <IMAGE>